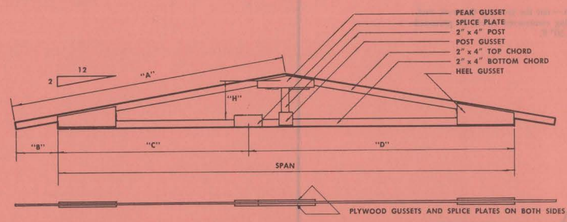
KING-POST NAIL-GLUED ROOF TRUSSES USING 2″ x 4″ MEMBERS—

2′ ON CENTER, 18′-0″ TO 24′-8″ SPANS
2/12 SLOPE 3/12 SLOPE 4/12 SLOPE

2/12 SLOPE

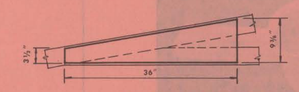


DESIGN DATA
Spans Up To 24′-8″
Recommended Design Load (psf. of horizontal projection)
Dead Load . . . . . 15 psf.
Live Load . . . . . 25 psf.
Total . . . . . 40 psf.

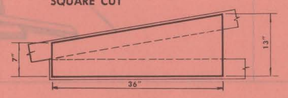
SPAN			18′			19′			20′			21′			22′			23′			24′		
			0″	4″	8″	0″	4″	8″	0″	4″	8″	0″	4″	8″	0″	4″	8″	0″	4″	8″	0″	4″	8″
TOP CHORDS	Length	"A"	12′-0″						14′-0″						16′-0″								
	Overhang	"B"	33″	31″	29″	27″	25″	23″	45″	43″	41″	39″	37″	35″	33″	31″	29″	51″	49″	47″	45″	43″	41″
BOTTOM CHORDS	Member	"C"	7′-0″			8′-0″			9′-0″									10′-0″					
	Cut Member	"D"	11′-0″	11′-4″	11′-8″	12′-0″	11′-4″	11′-8″	12′-0″	11′-4″	11′-8″	12′-0″	12′-4″	12′-8″	13′-0″	13′-4″	13′-8″	14′-0″	13′-4″	13′-8″	14′-0″	14′-4″	14′-8″
POST			17⅝″	18″	18¼″	18¾″	19″	19¼″	19⅝″	20″	20¼″	20⅝″	21″	21¼″	21⅝″	22″	22¼″	22⅝″	23″	23¼″	23⅝″	24″	24¼″
HEIGHT		"H"	18″	18⅜″	18⅝″	19″	19⅜″	19⅝″	20″	20⅜″	20⅝″	21″	21⅜″	21⅝″	22″	22⅜″	22⅝″	23″	23⅜″	23⅜″	24″	24⅜″	24⅜″

PLYWOOD GUSSETS

HEEL GUSSETS

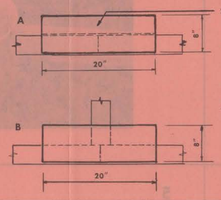


SQUARE CUT



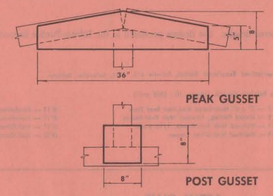
BEVELED BOTTOM CHORD
The bottom chord can be beveled to lower roof line, and to simplify finish, trim, and placement on masonry and brick walls.

SPLICE JOJNTS
FOR ⅜″ PLYWOOD

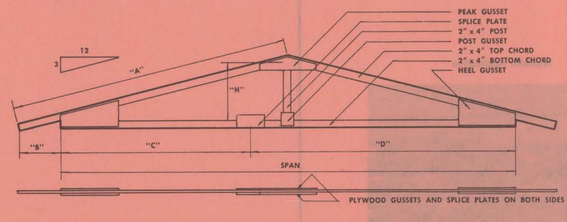


½″ PLYWOOD ONLY

PEAK AND POST GUSSETS



3/12 SLOPE

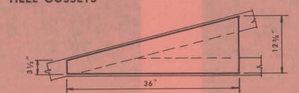


DESIGN DATA
Spans Up To 24′-8″
Recommended Design Load (psf. of horizontal projection)
Dead Load . . . . . 15 psf.
Live Load . . . . . 25 psf.
Total . . . . . 40 psf.

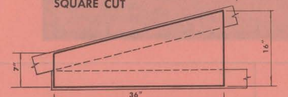
SPAN			18′			19′			20′			21′			22′			23′			24′		
			0″	4″	8″	0″	4″	8″	0″	4″	8″	0″	4″	8″	0″	4″	8″	0″	4″	8″	0″	4″	8″
TOP CHORDS	Length	"A"	12′-0″						14′-0″						16′-0″								
	Overhang	"B"	31″	29″	27″	25″	23″	21″	42⅝″	40⅝″	38⅝″	36⅝″	34⅝″	32⅝″	30⅝″	28⅝″	26⅝″	48¼″	46¼″	44¼″	42¼″	40¼″	38¼″
BOTTOM CHORDS	Member	"C"	7′-0″			8′-0″			9′-0″									10′-0″					
	Cut Member	"D"	11′-0″	11′-4″	11′-8″	12′-0″	11′-4″	11′-8″	12′-0″	11′-4″	11′-8″	12′-0″	12′-4″	12′-8″	13′-0″	13′-4″	13′-8″	14′-0″	13′-4″	13′-8″	14′-0″	14′-4″	14′-8″
POST			26½″	27″	27½″	28″	28½″	29″	29½″	30″	30½″	31″	31½″	32″	32½″	33″	33½″	34″	34½″	35″	35½″	36″	36½″	37″
HEIGHT		"H"	27″	27½″	28″	28½″	29″	29½″	30″	30½″	31″	31½″	32″	32½″	33″	33½″	34″	34½″	35″	35½″	36″	36½″	37″

PLYWOOD GUSSETS

HEEL GUSSETS

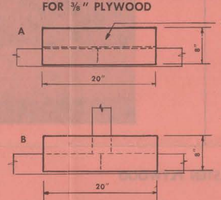


SQUARE CUT

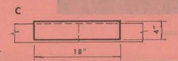


BEVELED BOTTOM CHORD
The bottom chord can be beveled to lower roof line, and to simplify finish, trim, and placement on masonry and brick walls.

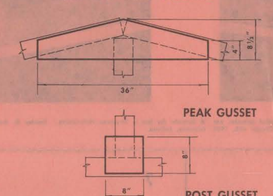
SPLICE JOJNTS
FOR ⅜″ PLYWOOD



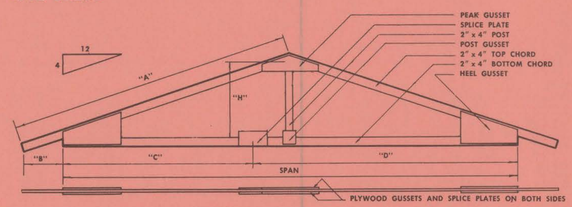
½″ PLYWOOD ONLY



PEAK AND POST GUSSETS



4/12 SLOPE

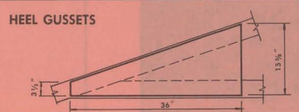


DESIGN DATA
Spans Up To 24′-8″
Recommended Design Load (psf. of horizontal projection)
Dead Load . . . . . 15 psf.
Live Load . . . . . 25 psf.
Total . . . . . 40 psf.

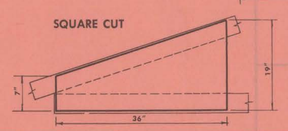
SPAN			18′			19′			20′			21′			22′			23′			24′		
			0″	4″	8″	0″	4″	8″	0″	4″	8″	0″	4″	8″	0″	4″	8″	0″	4″	8″	0″	4″	8″
TOP CHORDS	Length	"A"	12′-0″						14′-0″						16′-0″								
	Overhang	"B"	27″	25″	23″	21″	19″	17″	39″	37″	35″	33″	31″	29″	27″	25″	23″	44″	42″	40″	38″	36″	34″
BOTTOM CHORDS	Member	"C"	7′-0″			8′-0″			9′-0″									10′-0″					
	Cut Member	"D"	11′-0″	11′-4″	11′-8″	12′-0″	11′-4″	11′-8″	12′-0″	11′-4″	11′-8″	12′-0″	12′-4″	12′-8″	13′-0″	13′-4″	13′-8″	14′-0″	13′-4″	13′-8″	14′-0″	14′-4″	14′-8″
POST			35⅜″	36″	36⅝″	37⅜″	38″	38⅝″	39⅜″	40″	40⅝″	41⅜″	42″	42⅝″	43⅜″	44″	44⅝″	45⅜″	46″	46⅝″	47⅜″	48″	48⅝″
HEIGHT		"H"	36″	36⅝″	37⅜″	38″	38⅝″	39⅜″	40″	40⅝″	41⅜″	42″	42⅜″	43⅜″	44″	44⅜″	45⅜″	46″	46⅜″	47⅜″	48″	48⅜″	49⅜″

PLYWOOD GUSSETS

HEEL GUSSETS

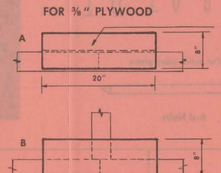


SQUARE CUT

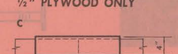


BEVELED BOTTOM CHORD
The bottom chord can be beveled to lower roof line, and to simplify finish, trim, and placement on masonry and brick walls.

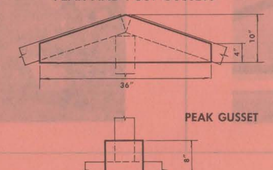
SPLICE JOJNTS
FOR ⅜″ PLYWOOD



½″ PLYWOOD ONLY



PEAK AND POST GUSSETS



MATERIALS AND NAIL-GLUING FABRICATION

- Each structural member should have a moisture content of 19% or less.
- Structural lumber for the chords must be No. 1 southern yellow pine (1500 psi., stress grade) or reselected construction grade Douglas fir or western hemlock. (See reselection procedure given in Small Homes Council Instruction Sheet #12, *Reselection of Lumber for Roof Trusses.*) The lumber reselected by this process is equivalent to 1500 psi., stress grade, throughout its entire length.
- Use unsanded grade plywood, ⅜″ or ½″ thick. The plywood must meet Commercial Standards CS 45-60 as certified by an approved testing laboratory.
- Splice "A" or "B" is recommended for ⅜″ plywood. Splice "A," "B," or "C" is recommended for ½″ plywood.
- The surface grain of the plywood should run parallel to the bottom chord for all plates.
- Use 4d common nails or 1⅛″ staples for nail-gluing the plywood gusset plates; 6d common nails for 1″ solid wood splice plates. Space the fasteners 4 inches apart in two rows and ⅜ inch from the edges.
- The casein glue must meet Federal Specification MMM-A-125, Type I or II. Mix the glue according to the manufacturer's instructions. Protect the trusses from rain. After nailing, stack the trusses and do not handle them during the curing period.
- Fabricate and cure the trusses above 50°F. When the temperature is between 50°F. and 70°F., a 16-hour curing period is necessary; when the temperature is 70°F. or above, an 8-hour curing period is needed.

The material schedules above are based on a design using the square-cut heel gusset, Splice Joint "A" or "C," and peak and post gussets.

If Splice Joint "B" is used, post gussets are not required, but the bottom-chord dimensions must be changed.

If the beveled bottom-chord detail is selected, the dimension of the post must be changed.

STRUCTURAL DESIGN DATA FOR KING-POST TRUSSES

The graphical methods of analysis generally used for trusses designed with pin-connected joints should not be used for analyzing trusses with nail-glued plywood gussets because the rigidity of the nail-glued joints produces an entirely different stress distribution. Bending stresses become important in the rigid joint truss while the diagram analysis ignores them completely; furthermore, experimental stress analysis has shown that the actual axial stresses are substantially lower than those calculated in the diagram analysis. The large peak and heel gussets cause the top chords of the king-post trusses to act as beams with partially restrained ends; therefore, the distribution of stresses in the top chords is considerably different and has been experimentally shown to be less than that for a pin-connected member. The bottom chord is primarily a tension member. It acts as a two-span continuous beam, partially restrained at the center and ends, and it resists a moment which is transferred through the heel gusset from the top chords. The center post is in tension.

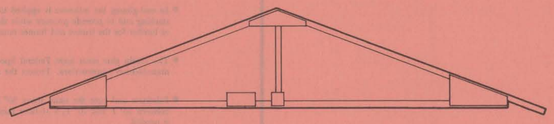
The original king-post truss designs were based on test results: (1) from full-size trusses tested individually in a multiple-cylinder hydraulic testing machine, and (2) on pairs of trusses set up 24″ on center, sheathed, bridged for lateral support, and loaded with concrete blocks as live load on the roof surface and bottom chord. The data on this sheet were based upon test results from pairs of trusses set up as previously described. The trusses were fabricated with ⅜″ plywood and reselected west coast hemlock.

Two types of tests were made to determine the performance of this design: load-and-recovery and load-to-destruction tests. In the load-and-recovery test (a performance test to observe the behavior of a truss in excess of design loads), a load of 100 psf., equaling two and one-half times the design load, was applied to the truss. Deflection readings were taken as the load was applied in increments of 20 pounds per sq. ft. Residual deflection was measured after the entire load was removed. This test determined the maximum load the truss could carry for acceptable performance. The nail-glued king-post trusses are exceptionally stiff and will sustain loads of at least 100 psf.

The destruction test determined: (1) the maximum load capacity of the truss, (2) the behavior when greatly over-stressed, and (3) the critical points of the design. The king-post nail-glued trusses fabricated with reselected west coast hemlock carried at least two and one-half times the design load before failure.

Nail-glued roof-trusses do not require precise cutting and fitting of members, but the builder must use good judgment in the selection of materials and must follow the simple instructions for gluing, nailing, curing, and handling the trusses as set forth in the Small Homes Council Instruction Sheet, #1, *Nail-Gluing of Roof Trusses and Frames.* **The quality of material and workmanship will determine the ultimate strength of the truss.**

PERFORMANCE DATA ON 2″ x 4″ KING-POST TRUSSES
Spans Up To 24′-8″

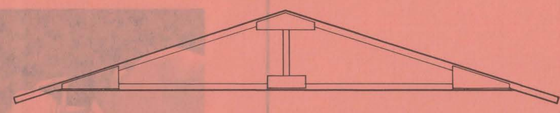


2/12 SLOPE
Deflection from 40 psf., mid-point . . . . . 0.31″
Residual set after release of 100 psf. . . . . 0.09″
Test load at failure . . . 135# psf.

3/12 SLOPE
Deflection from 40 psf., mid-point . . . . . 0.21″
Residual set after release of 100 psf. . . . . 0.02″
Test load at failure . . . 145# psf.

4/12 SLOPE
Deflection from 40 psf., mid-point . . . . . 0.19″
Residual set after release of 100 psf. . . . . 0.05″
Test load at failure . . . 100# psf. (Supported load, 18 days)

PERFORMANCE DATA ON 2″ x 4″ KING-POST TRUSSES WITH CENTER-JOINT AND HEEL-JOINT VARIATIONS
Spans Up To 24′-8″



2/12 SLOPE
Deflection from 40 psf., mid-point . . . . . 0.50″
Residual set after release of 100 psf. . . . . 0.05″
Test load at failure . . . 100# psf. (Supported load, 3 days)

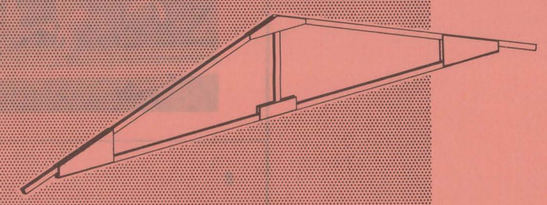
3/12 SLOPE
Deflection from 40 psf., mid-point . . . . . 0.26″
Residual set after release of 100 psf. . . . . 0.05″
Test load at failure . . . 100# psf. (Supported load, 8 days)

4/12 SLOPE
Deflection from 40 psf., mid-point . . . . . 0.21″
Residual set after release of 100 psf. . . . . 0.03″
Test load at failure . . . 100# psf. (Supported load, 7 days)

KING-POST NAIL-GLUED ROOF TRUSSES USING 2″ x 4″ MEMBERS — 2/12, 3/12, 4/12 SLOPES

2′ on Center, 18′-0″ to 24′-8″ Spans

INSTRUCTION SHEET #6



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NAIL-GLUING OF ROOF TRUSSES, FRAMES AND OTHER STRUCTURAL COMPONENTS

1 NAIL-GLUE FOR STRENGTH AND ECONOMY

- Nail-gluing makes possible roof trusses, frames, and other structural components which are very stiff and strong. A glued joint holds two members firmly without slippage.
- In nail-gluing, the adhesive is applied to the structural members and nails or staples are used only to give rigidity to the unit during handling and stacking and to provide pressure while the glue sets. The strength of the finished connection is entirely dependent on the glue bond. Moisture content of lumber for the trusses and frames must be 19% or less.
- The casein glue must meet Federal Specification MMM-A-125, Type I or II. (Type II contains a mold inhibitor.) Mix the glue according to the manufacturer's instructions. Protect the units from rain. After nailing, stack and do not handle again during the curing period.
- Fabricate and cure the units above 50° F. The lumber and plywood likewise should not be below 50° F for nail-gluing. When the temperature is between 50° F and 70° F, a 16-hour minimum curing period is necessary; when the temperature is 70° F or above an 8-hour minimum curing period is needed.
- Nail-gluing should be used only with properly engineered designs. Use designs presented in the Illinois-Purdue instruction sheets for nail-glued trusses and roof-frames.*

* **Design of Nail-Glued Plywood Gusset Plates**, Purdue University Agricultural Experiment Station, Bulletin 613, 1954, Lafayette, Indiana.

Instruction Sheets, University of Illinois Small Homes Council–Building Research Council, Urbana, Ill. (50¢ each)

#2 — 2/12 Nail-Glued "W" Roof Truss
#3 — 3/12 Nail-Glued "W" Roof Truss
#4 — 4/12 Nail-Glued "W" Roof Truss
#5 — Long-Span Nail-Glued "W" Roof Truss
#6 — 2" x 4" Nail-Glued King-Post Roof Truss
#7 — 2" x 6" Nail-Glued King-Post Roof Truss
#8 — Sloped Ceiling, Plywood Web Roof-Frames
#9 — Plywood Web Roof-Frame, 1/12 Slope
#10 — Hip-Roof Nail-Glued Trusses
#12 — Reselection of Lumber for Roof Trusses
#13 — Variations for Building Nail-Glued "W" Roof Truss
#21 — Nail-Glued Header for Wall Panels
#22 — Nail-Glued Headers for Larger Openings

2 MIX GLUE

Casein glue is recommended. The glue must meet Federal Specifications MMM-A-125, Type I or Type II. (Type II contains a mold inhibitor which is required by some local authorities.) The glue must be mixed according to the manufacturer's instructions. Thin or watery mixtures must be avoided.

3 LAY OUT STRUCTURAL COMPONENT

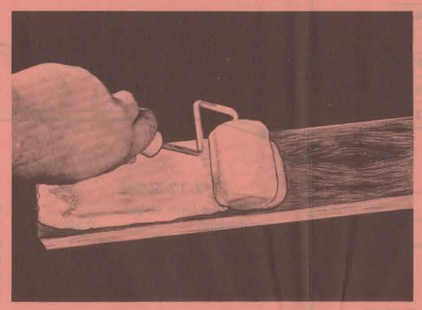
Lay out on a flat, sturdy surface (jig, subfloor or slab — not the ground) the truss, roof-frame or other component to be built. The units being constructed should be protected against rain and allowed to cure at temperatures above 50° F.

Do not use second-hand or dirty lumber.

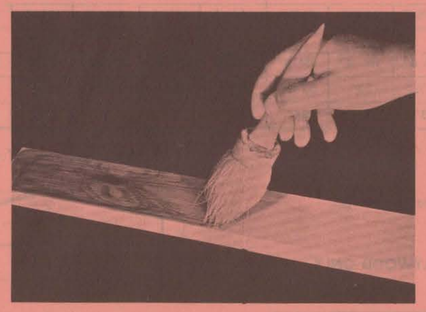
4 APPLY GLUE

Apply glue directly to the lumber members by means of a paint roller, glue brush or mechanical glue spreader. *

Paint Roller



Glue Brush



* For information and specifications for mechanical spreader, use "A Spreader for Use in Structural Nail-Gluing," Stanley K. Suddarth, Purdue University, Agricultural Experiment Station Circular 408, 1954, Lafayette, Indiana.

5 USE PLENTY OF GLUE

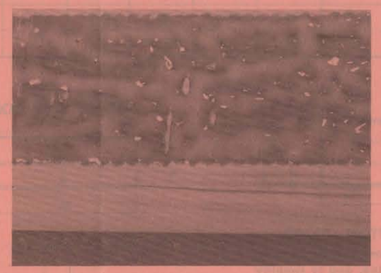
Use plenty of glue on the structural members to cover the entire area of contact. Glue need not be spread on gusset plates.

A correct spread of glue on the wood will look like that shown below.

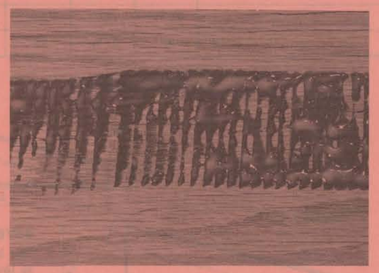
A glue spread which is too thin, such as shown in second photograph, will not give adequate glue bond.

A more than adequate glue spread, also illustrated, will result in a good glue bond but the practice is wasteful.

Correct Application



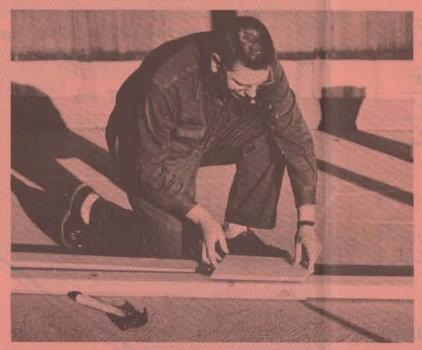
Inadequate Application



Wasteful Application

6 PUT PLYWOOD IN POSITION

After the glue has been applied to the lumber members, place the plywood in position on the glue area and fasten.



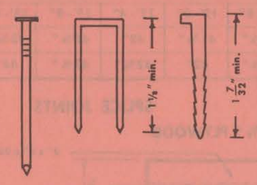
7 FASTEN PLYWOOD

Nail or staple plywood preferably by means of a mechanical fastening device. Drive fasteners hard so that their heads are buried in the plywood. Solid-wood splice plates must be nailed manually with common wire nails.

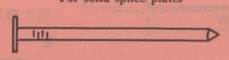
Mechanical Fastening

Types of Fasteners Used

For plywood gussets

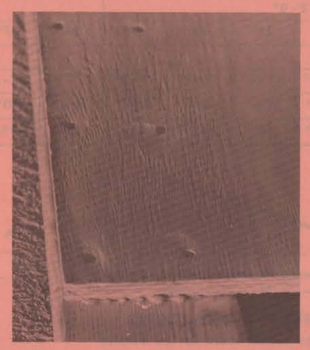


For solid splice plates

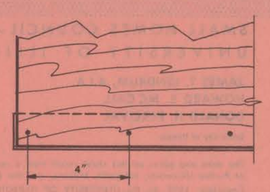


6-d Nails

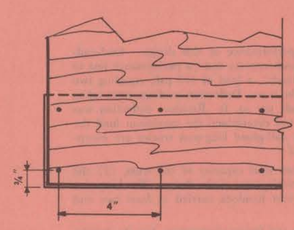
Nail Heads Buried in Plywood



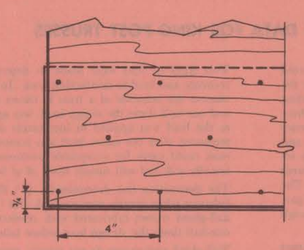
8 FASTEN ACCORDING TO PATTERN



For members 1¾" wide use one row of fasteners spaced 4" apart.



For members 3⅜" wide, use two rows of fasteners spaced 4" apart.



For members 5½" wide use two rows of fasteners spaced 4" apart and stagger a third row down the center of the member.

9 JUDGE GLUE JOINT BY SQUEEZE-OUT

When two members are fastened together, some of the glue will be squeezed out if the correct amount of glue has been used. This is visual certification of a good glue joint.